

4. Nonroad Mobile Sources

4.1 Introduction

Nonroad mobile sources are defined as those sources that move or are moved within a 12-month period and are not licensed or certified as highway vehicles. Nonroad mobile sources are vehicles and engines that fall under the following categories:

- Agricultural equipment, such as tractors, combines and balers;
- Airport ground support equipment, such as baggage tugs and terminal tractors;
- Commercial equipment, such as generators and pumps;
- Industrial equipment, such as forklifts and sweepers;
- Construction and mining equipment, such as graders, back hoes and trenchers;
- Lawn and garden equipment, such as leaf blowers and lawn mowers;
- Logging equipment (not present in Maricopa County);
- Pleasure craft, such as power boats and personal watercraft;
- Railway maintenance equipment, such as rail straighteners;
- Recreational equipment, such as all-terrain vehicles and off-road motorcycles;
- Underground mining and oil field equipment (not present in Maricopa County);
- Aircraft, such as jet and piston engines; and
- Locomotives, such as switching and line haul trains.

Emission calculations for most nonroad mobile source categories except aircraft, airport ground support equipment (GSE) and locomotives were derived using EPA's NONROAD model, ver. 2008.1.0 (Core version 2008, April 2009). Aircraft and airport GSE emission estimates were made using the Federal Aviation Administration's EDMS (Emissions Dispersion Modeling System) model, ver. 5.1.1. Locomotive emission calculations were derived from surveys of the three railroad companies that have operations in the county (Burlington Northern Santa Fe, Union Pacific and Amtrak).

County specific temperature and fuel-related inputs are required for the operation of the NONROAD model. Monthly temperature and fuel data were provided by the Arizona Department of Weights and Measures. Table 4.1-1 below lists the local county inputs used:

Table 4.1–1. NONROAD model county temperature- and fuel-related inputs.

Month	Temperatures (°F)			Fuel RVP (psi)	Diesel Sulfur (ppm)	Gasoline Sulfur (ppm)	Ethanol Blend		
	Max.	Min.	Average				ETOH (Vol%)	Market Share (%)	Total Oxygen (wt%)
January	64	45	54.90	8.8	6	35	9.47	100	3.49
February	69	48	58.45	8.4	6	23	9.24	100	3.42
March	79	54	66.84	8.4	7	49	9.18	100	3.41
April	87	61	74.23	7.8	7	23	5.57	100	2.06
May	91	66	78.74	6.8 *	6 *	27*	0.00*	0*	0.00*
June	107	80	93.40	6.6	6	25	0.00	0	0.00
July	106	84	95.16	7.0	4	19	0.00	0	0.00
August	104	82	93.16	6.8	6	29	0.00	0	0.00
September	101	79	90.07	6.5	6	35	0.00	0	0.00
October	91	65	78.13	7.9	7 †	25	6.79	100	2.52
November	81	56	68.67	8.4	7 †	15	8.78	100	3.27
December	65	46	56.03	8.3 †	7	28†	8.17†	100†	3.03†

* Since measurements were not available, the average of June, July, August and September data was used.

† Since measurements were not available, the average of October, November, January, February, March and April data was used.

EPA recommends adjusting default NONROAD model values (such as equipment population, activity levels of equipment, growth factors, etc.) where local data is available, as the default values in the model are derived from national averages.

NONROAD model default values were adjusted based on 2003 survey results of the commercial lawn and garden industry as part of an inventory developed to study the impact of visibility impairing pollutants (ENVIRON et al., 2003). Survey results show that for most categories of lawn and garden equipment, the equipment population estimates for Maricopa County are significantly lower than EPA default values, while the average annual hours of operation for most equipment types are slightly higher than EPA's values. Using these local data results in a considerable decrease in emissions from this category, compared with earlier results using EPA default data.

Spatial allocation factors were developed (based on EPA guidance documents) to apportion non-road emissions to the CO maintenance area. The approaches used are described in each section of this chapter.

Temporal allocations (used to calculate CO season-day emissions) for nonroad equipment categories modeled in the NONROAD model come from EPA recommendations on weekday and weekend day activity levels for each nonroad equipment category (US EPA, 1999). Table 4.1–2 below lists the weighted activity level allocation fractions for each equipment class for weekdays and weekend days. For this report, the most conservative (highest) allocation fraction in each nonroad equipment class was used to calculate season-day emissions.

Table 4.1–2. Default weekday and weekend day activity allocation fractions.

Equipment category	Weekday	Weekend day
Agricultural	0.1666667	0.0833334
Airport ground support	0.1428571	0.1428571
Commercial	0.1666667	0.0833334
Construction and mining	0.1666667	0.0833334
Industrial	0.1666667	0.0833334
Lawn and garden (residential)	0.1111111	0.2222222
Lawn and garden (commercial)	0.1600000	0.1000000
Pleasure craft	0.0600000	0.3500000
Railway maintenance	0.1800000	0.0500000
Recreational	0.1111111	0.2222222

4.2 Agricultural equipment

Annual emissions from agricultural equipment in Maricopa County were calculated using EPA’s NONROAD model, as discussed above. CO maintenance area annual emissions were calculated based on EIIP guidance (US EPA, 2002) which recommends using the ratio of agricultural land inside the maintenance area (84,979 acres) to agricultural land inside the county (295,509 acres). See Section 1.5.2 for a discussion of land-use data used.

County season-day emissions were calculated by multiplying CO season emissions (generated by the NONROAD2002 model) by the most conservative weekday/weekend day activity allocation factor for agricultural equipment listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999).

CO maintenance area season-day emissions were calculated by multiplying county season-day emissions by the agricultural land-use allocation factor.

Table 4.2–1. Annual and season-day CO emissions from agricultural equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	367.01	513.7
CO Maintenance Area	105.55	147.7

4.3 Airport ground support equipment

Annual emissions from airport ground support equipment (GSE) and auxiliary power units (APUs) at most airports in the county were estimated using the Emissions Dispersion Modeling System (EDMS, v. 5.1.1) from the U.S. Federal Aviation Administration (FAA). The model can estimate emissions from affiliated GSE and APUs, by using either default equipment profiles, or user-specified data on equipment populations and activity patterns. In most cases, activity data on 2008 aircraft operations and GSE/APU usage was obtained from individual airport surveys issued by MAG and/or MCAQD. Where survey responses were incomplete or information was otherwise unavailable, activity data was estimated using commercially available data, and EDMS default assumptions where appropriate. Further details concerning the modeling input data and results are presented in Section 4.11 of this report.

For Luke Air Force Base (AFB), emissions estimates for ground support equipment were obtained from a recent base-wide mobile source emissions inventory for calendar year 2008 that

had recently been completed for the US Air Force (Weston, 2010). GSE emissions from the Luke AFB study were added to the EDMS-estimated emissions from the other airports in the County. (The Luke study assumed APU usage, and thus emissions, to be negligible.) A simplifying assumption was made for all airports; i.e., that activity is spread fairly evenly throughout the week and year; thus CO season day emissions were estimated by dividing annual totals by 366 (= days/yr in 2008). Table 4.3–1 below presents the totals for all airport GSE and APU usage within both Maricopa County and the CO maintenance area, on an annual and season-day basis, respectively.

Table 4.3–1. Annual and season day CO emissions from airport ground support equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	4,842.26	26,460.4
CO Maintenance Area	4,765.55	26,041.3

4.4 Commercial equipment

Annual emissions from commercial equipment in Maricopa County were calculated using EPA’s NONROAD model, as described in Section 4.1. Annual emissions for the CO maintenance area for this category were derived by applying the ratio of industrial employment in the maintenance area to Maricopa County-level totals, as data on the number of wholesale establishments recommended by EIIP guidance (US EPA, 2002) was not available. See Section 1.5.1 for a discussion of the industrial employment data used.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/ weekend day activity allocation factor for commercial equipment (0.1666667) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on industrial employment ratios as described above.

Table 4.4–1. Annual and season day CO emissions from commercial equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	37,407.59	204,928.7
CO Maintenance Area	36,816.55	201,690.8

4.5 Construction and mining equipment

Annual emissions from construction and mining equipment in Maricopa County were calculated using EPA’s NONROAD model as described in Section 4.1. Annual emissions for the CO maintenance area for this category were derived by applying the ratio of population in the maintenance area to Maricopa County-level totals as a conservative estimate, as the EIIP-recommended allocation factor of total dollar value of construction was unavailable (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/ weekend day activity allocation factor for construction/mining equipment (0.1666667) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO

maintenance area season-day emissions were calculated based on population ratios as described above.

Table 4.5–1. Annual and season day CO emissions from construction and mining equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	17,097.10	90,379.7
CO Maintenance Area	15,753.27	83,275.9

4.6 Industrial equipment

Annual emissions from industrial equipment in Maricopa County were calculated using EPA’s NONROAD model, as described in Section 4.1. Annual emissions for the CO maintenance area for this category were derived by applying the ratio of industrial employment in the maintenance area to Maricopa County-level totals as a conservative estimate, as the number of employees in manufacturing recommended by EIIP guidance (US EPA, 2002) was not available. See Section 1.5.1 for a discussion of the industrial employment data used.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for industrial equipment (0.1666667) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on industrial employment ratios as described above.

Table 4.6–1. Annual and season day CO emissions from industrial equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	10,294.56	64,617.8
CO Maintenance Area	10,131.90	63,596.8

4.7 Lawn and garden equipment

Annual emissions from lawn and garden equipment in Maricopa County were calculated using EPA’s NONROAD model, as described in Section 4.1. These results reflect new equipment population and usage estimates from survey work done in early 2003 for the Arizona Department of Environmental Quality (discussed further in Section 4.1). Annual emissions for the CO maintenance area for this category were derived by applying the ratio of population in the maintenance area to Maricopa County-level totals, since housing units was not available, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for lawn and garden equipment (0.1600000 for the commercial segment, 0.2222222 for residential) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on population as described above.

Table 4.7–1. Annual and season day CO emissions from lawn and garden equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	66,712.36	100,753.6
CO Maintenance Area	64,657.62	97,650.4

4.8 Pleasure craft

Annual emissions from pleasure craft equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. Annual emissions for the CO maintenance area for this category were derived by applying the ratio of water surface area in the maintenance area to Maricopa County-level totals, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.2 for a discussion of the land-use data used.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for pleasure craft (0.350000) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on water surface area as described above.

Table 4.8–1. Annual and season day CO emissions from pleasure craft equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	1,627.41	5,008.5
CO Maintenance Area	431.81	1,328.9

4.9 Railway maintenance equipment

Annual emissions from railway maintenance equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. Annual emissions for the CO maintenance area for this category were derived by applying the ratio of population in the maintenance area to Maricopa County-level totals, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for railway maintenance equipment (0.1800000) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on the population ratio as described above.

Table 4.9–1. Annual and season day CO emissions from railway maintenance equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	19.33	120.8
CO Maintenance Area	18.73	117.1

4.10 Recreational equipment

Annual emissions from recreational equipment in Maricopa County were calculated using EPA's NONROAD model (see Section 4.1). Annual emissions for the CO maintenance area were

derived by applying the ratio of passive open space, golf courses and vacant land use in the CO maintenance area to Maricopa County-level totals per EIIP guidance (US EPA, 2002). See Section 1.5.2 for a discussion of the land use data used.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for recreational equipment (0.2222222) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on land use as described above.

Table 4.10–1. Annual and season day CO emissions from recreational equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	7,270.41	24,593.7
CO Maintenance Area	412.23	1,394.5

4.11 Aircraft

Emissions from aircraft operations at the largest civilian airports in Maricopa County were estimated using the Federal Aviation Administration’s Emissions and Dispersion Model (EDMS, v. 5.1.1). The EDMS model combines specified aircraft type and activity levels with default emission factors in order to estimate annual emissions inventories for a specific airport. The model also estimates emissions from affiliated ground support equipment (GSE) and auxiliary power units (APUs); these emissions are reported separately and are summarized in Section 4.3.

MCAQD surveyed medium and large airports in Maricopa County to gather data on aircraft type and activity level of aircraft operations. Specifically, the number of landing and takeoff cycles, or (LTO’s) or touch and go operations, (TGOs), along with information on the types of aircraft that comprise the airport’s typical fleet mix, and other operational data, such as typical usage patterns of ground support equipment (GSE) and auxiliary power units (APUs), average taxi/idle times, etc. Where survey responses were unavailable or incomplete, aircraft activity data from publicly accessible databases, such as the FAA’s Air Traffic Activity Data System (ATADS) and Enhanced Traffic Management System Counts (ETMSC), were used.

All emission estimates in this section have been developed using the EDMS model, with the exception of Luke Air Force Base (AFB), whose emissions calculations have been prepared as part of a base-wide 2008 mobile source emissions inventory that has recently been completed (Weston, 2010). Luke AFB’s emissions reported as ‘aircraft activity’ actually comprise three distinct, though related, types of activity: (1) the operation of aircraft stationed at the base, (2) a much smaller level of “transient” aircraft traffic within Luke’s airspace, and (3) emissions produced during on-wing engine testing – considered a “mobile source” emission category. As with all other airports included in this inventory, emissions from ground support equipment (GSE) at Luke AFB are addressed in Section 4.3.

In addition to the LTOs (and occasional TGO activity) reported by other airports in the area, Luke reported two additional, types of aircraft operations: aircraft low fly bys (LFB), and aircraft low fly patterns (LFP). Each of these types of operations can be characterized by a distinctive combination of the times in mode (TIM); (e.g., approach, taxi in/out, takeoff and climb out.) Luke’s emissions are not based on the number of LTOs, but rather the aggregate annual operational time in modes (TIMs) for all aircraft of similar type. For the F-16, an LTO cycle includes

five modes of operation: idle (taxi in/out), intermediate, approach, military and afterburner. F-16 emissions were estimated using the annual TIMs provided by Luke AFB and emission factors from military guidance documents.

Table 4.11–1 lists the data sources for each airport’s activity level, as well as fleet mix. The total number of aircraft operations in 2008 is also listed. For all airports other than Luke AFB, aircraft emissions were estimated for four aircraft categories:

- Air carriers (abbreviated “AC”): Larger commercial aircraft with at least 60 seats or 18,000 lbs payload capacity, used for scheduled service to transport passengers and/or freight;
- Air taxis (“AT”): Smaller commercial turbine- or piston-powered aircraft with less than 60 seats or 18,000 lbs payload capacity;
- General aviation (“GA”): Aircraft used on an unscheduled basis for recreational flying, personal transportation, and other activities, including business travel; and
- Military (“ML”): Aircraft used to support military operations.

Table 4.11–1. Annual airport operations (by aircraft category), and related data sources.

Airport	Airport Code	Operations Data Source ¹	Fleet Mix Data Source ²	Aircraft Type	2008 Operations
Buckeye Municipal	BXK	airnav.com	Generic GA profile	GA	26,535
Chandler Municipal	CHD	FAA/ATADS	FAA/ETMSC	AT	2,882
				GA	233,713
				ML	247
Falcon Field	FFZ	FAA/ATADS	FAA/ETMSC	AC	6
				AT	3,813
				GA	313,448
				ML	2,152
Gila Bend Municipal	E63	airnav.com	Generic GA profile	GA	1,768
Glendale Municipal	GEU	FAA/ATADS, Survey response	FAA/ETMSC	AT	1,873
				GA	134,282
				ML	57
Luke Air Force Base	LUF	[Emission totals provided by Luke AFB are based on times-in-mode.]			
Phoenix Deer Valley	DVT	Survey response	Survey response, FAA/ETMSC	AC	284
				AT	6,217
				GA	370,003 *
				ML	130
Phoenix Goodyear	GYR	Survey response	Survey response, FAA/ETMSC	AC	140
				AT	1962
				GA	169,177 *
				ML	6,747
Phoenix-Mesa Gateway (formerly Williams Gateway)	IWA	FAA/ATADS, Survey response	FAA/ETMSC	AC	3,876
				AT	5,937
				GA	211,674
				ML	5,939
Phoenix Sky Harbor	PHX	Survey response	Survey response, FAA/ETMSC	AC	391,518
				AT	77,354
				GA	30,868
				ML	2,759
Pleasant Valley	P48	airnav.com	Generic GA profile	GA	23,535
Scottsdale	SDL	FAA/ATADS	FAA/ETMSC	AT	11,232
				GA	179,619
				ML	560
Sky Ranch at Carefree	18AZ	Survey response	Generic GA profile	GA	1,515
Stellar Airpark	P19	airnav.com	Generic GA profile	GA	19,528
Wickenburg Municipal	E25	Survey responses	Generic GA profile	GA	6,000

1. FAA/ATADS: Federal Aviation Administration’s Air Traffic Activity Data System (database); <http://aspm.faa.gov>.

2. FAA/ETMSC: Federal Aviation Administration’s Enhanced Traffic Management System Counts (database); <http://aspm.faa.gov>.

* includes touch-and-go (TGO) operations levels reported by the airport.

The following section describes how activity and emissions were estimated for a representative airport, Chandler Municipal (CHD). Data from FAA’s Air Traffic Activity Data System (ATADS, <http://www.aspm.faa.gov>) provided data on 2008 activity by aircraft type; these results are contained in Table 4.11–1. While ATADS reported a total of 233,713 general aviation operations at this airport in 2008, further information on the aircraft types comprising this activity was needed. The FAA’s Enhanced Traffic Management System Counts (ETMSC) database was used to “grow” available aircraft-specific operational data as described below.

The ETMSC database on general aviation activity at CHD in 2008 comprises 152 different aircraft types, totaling 3,589 operations (See Table 4.11–2). To simplify modeling input requirements, this aircraft-specific activity data was ranked in order of decreasing frequency and activity data for the most frequently reported aircraft was then grown to represent all general aviation (“GA”) activity, as shown in Table 4.11–2 below.

Table 4.11–2. Example showing how most common aircraft-specific activity was grown for modeling.

Rank	Aircraft Type	ETMSC- reported operations	% of total reported operations	Cumulative Percent	“Grown” operations for EDMS modeling
1	BE20 - Beech 200 Super King	240	6.7%		21,919
2	BE58 - Beech 58	233	6.5%		21,280
3	PA28 - Piper Cherokee	233	6.5%		21,280
4	C525 - Cessna CitationJet/CJ1	232	6.5%		21,189
5	C182 - Cessna Skylane 182	203	5.7%	31.8%	18,540
6	C172 - Cessna Skyhawk 172/Cutlass	194	5.4%		17,718
7	TBM7 - Socata TBM-7	166	4.6%		15,161
8	R22 - Robinson R-22 Mariner	138	3.8%		12,604
9	BE9L - Beech King Air 90	106	3.0%		9,681
10	BE36 - Beech Bonanza 36	97	2.7%	51.3%	8,859
11	BE55 - Beech Baron 55	90	2.5%		8,220
12	BE35 - Beech Bonanza 35	87	2.4%		7,946
13	C210 - Cessna 210 Centurion	75	2.1%		6,850
14	PA32 - Piper Cherokee Six	73	2.0%		6,667
15	P28R - Cherokee Arrow/Turbo	71	2.0%	62.4%	6,484
16	P46T - Piper Malibu Meridian	67	1.9%		6,119
17	SR22 - Cirrus SR 22	67	1.9%		6,119
18	BE30 - Raytheon 300 Super King Air	65	1.8%		5,936
19	MO20 - Mooney M-20	62	1.7%		5,662
20	C560 - Cessna Citation V/Ultra/Encore	60	1.7%	71.3%	5,480
⋮	⋮	⋮	⋮	⋮	
152	XL2 - Liberty XL-2	1	< 0.1%	100.0%	(n/a)
Totals:		3,589			233,713

This approach of ranking reported activity, and then growing the most frequently occurring subset of aircraft typically resulted in a set comprised of 10 to 30 aircraft types being modeled for each airport/aircraft class combination, representing 60 to 100% of all reported activity. For ease in modeling computation and the assessment of emissions, all activity was assumed to occur evenly throughout the year. Thus, CO season day emissions were calculated by dividing annual totals by 366 (= days per year in 2008). Table 4.11–3 lists the total annual emissions and season-day emissions, of each airport and aircraft type, and for airports within and outside the CO maintenance area, respectively.

Table 4.11–3. Annual and season-day CO emissions, by airport and aircraft type.

Airport	Category¹	Annual CO Emissions (tons/yr)	Typical season day CO emissions (lbs/day)
Buckeye Muni (BXX)	Aircraft: GA	351.30	1,919.7
Chandler Muni (CHD)	Aircraft: AT	13.70	74.8
	Aircraft: GA	2,146.93	11,731.8
	Aircraft: ML	1.28	7.0
	CHD total	2,161.90	11,813.7
Falcon Field (FFZ)	Aircraft: AC	0.03	0.2
	Aircraft: AT	15.25	83.3
	Aircraft: GA	2,824.89	15,436.5
	Aircraft: ML	9.28	50.7
	FFZ total	2,849.45	15,570.8
Gila Bend Muni (E63)	Aircraft: GA	23.42	128.0
Glendale Muni (GEU)	Aircraft: AT	118.76	648.9
	Aircraft: GA	1,068.47	5,838.6
	Aircraft: ML	0.65	3.6
	GEU total	1,187.88	6,491.1
Luke AFB (LUF)	Aircraft: ML	665.20	3,635.0
Phx Deer Valley (DVT)	Aircraft: AC	2.29	12.5
	Aircraft: AT	26.75	146.2
	Aircraft: GA	3,159.04	17,262.5
	Aircraft: ML	0.83	4.5
	DVT total	3,188.91	17,425.7
Phx Goodyear (GYR)	Aircraft: AC	0.81	4.4
	Aircraft: AT	8.30	45.3
	Aircraft: GA	2,428.23	13,269.0
	Aircraft: ML	36.49	199.4
	GYR total	2,473.82	13,518.1
Phx Sky Harbor (PHX)	Aircraft: AC	1,795.49	9,811.4
	Aircraft: AT	200.51	1,095.7
	Aircraft: GA	151.06	825.5
	Aircraft: ML	24.69	134.9
	PHX total	2,171.75	11,867.5
Williams Gateway (IWA)	Aircraft: AC	14.37	78.5
	Aircraft: AT	30.55	166.9
	Aircraft: GA	823.11	4,497.8
	Aircraft: ML	48.93	267.4
	IWA total	916.95	5,010.7
Pleasant Valley (P48)	Aircraft: GA	2.70	14.7
Scottsdale (SDL)	Aircraft: AT	52.75	288.3
	Aircraft: GA	702.20	3,837.1
	Aircraft: ML	3.53	19.3
	SDL total:	758.48	4,144.7
Sky Ranch / Carefree	Aircraft: GA	11.61	63.4
Stellar Airpark (P19)	Aircraft: GA	294.75	1,610.7
Wickenburg Muni (E25)	Aircraft: GA	47.39	259.0
	County totals:	17,105.50	93,472.7
Maricopa County	Aircraft: AC	1,812.99	9,907.0
	Aircraft: AT	466.56	2,549.5
	Aircraft: GA	14,035.08	76,694.4
	Aircraft: ML	790.88	4,321.8
	Aircraft, total	17,105.50	93,472.7
CO Maintenance area: (excludes Buckeye, Gila Bend and Wickenburg)	Aircraft: AC	1,812.99	9,907.0
	Aircraft: AT	466.56	2,549.5
	Aircraft: GA	13,613.0	74,387.8
	Aircraft: ML	790.88	4,321.8
	Aircraft, total	16,683.40	91,166.1

1. AC = air carrier, GA = general aviation, AT = air taxi, ML = military.

4.12 Locomotives

Annual emissions from locomotives were calculated based on diesel fuel usage provided by Burlington Northern/Santa Fe Railway (BNSF), Union Pacific Railway (UP) and Amtrak. Railway operations from these companies fall into two categories: Class I haul lines and yard/switching operations. Annual emissions from Class I haul operations and yard/switching operations were calculated by multiplying diesel fuel usage by the emission factors listed in Table 4.12–1 (US EPA, 2009).

Table 4.12–1. Emission factors for locomotives.

Activity type	Emission factors (lbs/gal diesel)
Class I haul line	0.059
Yard/switch operations	0.061

Fuel use reported by railroads, and annual emission totals are summarized in Table 4.12–2.

Table 4.12–2. Fuel use and annual CO emissions from locomotives in Maricopa County.

Locomotive type	Diesel fuel used (gals)	Annual CO emissions (tons/yr)
BNSF Class I haul line	750,094	22.13
UP Class I haul line	7,780,284	229.52
BNSF yard/switch operations	400,000	12.20
UP yard/switch operations	378,199	11.54
Amtrak	52,416	1.55
Totals:	9,360,993	276.93

CO maintenance area emissions were calculated by multiplying Maricopa County emissions by the percentage of track miles inside the CO maintenance area, determined by GIS mapping. Results are shown in Table 4.12–3.

Table 4.12–3. Annual CO emissions (in tons/yr) from locomotives in the CO maintenance area.

Locomotive type	Track in maintenance area (%)	Annual CO emissions (tons/yr)
BNSF Class I haul line	37.95	8.40
UP Class I haul line	37.95	87.10
BNSF yard/switch operations	100.00	12.20
UP yard/switch operations	100.00	11.54
Amtrak	0.00	0.00
Totals:		119.23

CO season-day emissions for both the county and the CO maintenance area (shown in Table 4.12–4) were calculated by dividing annual totals by 366 days per year (= days/yr in 2008), as locomotive activity is assumed to be uniform throughout the year.

Table 4.12–4. Season-day emissions (in lbs/day) from locomotives in Maricopa County and the CO maintenance area.

Locomotive type	Maricopa County	CO maintenance area
BNSF Class I haul line	120.9	45.9
UP Class I haul line	1,254.2	476.0
BNSF yard/switch operations	66.7	66.7
UP yard/switch operations	63.0	63.0
Amtrak	8.4	0.0
Totals:	1,513.3	651.6

4.13 Summary of all nonroad mobile source emissions

Table 4.13–1 summarizes the annual and season-day emissions of carbon monoxide from nonroad mobile sources in Maricopa County and the CO maintenance area.

Table 4.13–1. Summary of annual and season-day CO emissions from nonroad mobile sources.

Equipment category	Annual CO emissions (tons/yr)		Season-day CO emissions	
	Maricopa County	CO maintenance area	Maricopa County	CO maintenance area
Agricultural	367.01	513.7	105.55	147.7
Airport GSE (+APU)	4,842.26	26,460.4	4,765.55	26,041.3
Commercial equipment	37,407.59	204,928.7	36,816.55	201,690.8
Construction & mining equipment	17,097.10	90,379.7	15,753.27	83,275.9
Industrial equipment	10,294.56	64,617.8	10,131.90	63,596.8
Lawn & garden equipment	66,712.36	100,753.6	64,657.62	97,650.4
Pleasure craft	1,627.41	5,008.5	431.81	1,328.9
Railway maintenance	19.33	120.8	18.73	117.1
Recreational equipment	7,270.41	24,593.7	412.23	1,394.5
Aircraft	17,105.50	93,472.7	16,683.40	91,166.1
Locomotives	276.93	1,513.3	119.23	651.6
Totals:	163,020.46	612,362.8	149,895.85	567,061.0

4.14 Quality assurance procedures

Established procedures were used to check, and correct when necessary, the off-road mobile sources emissions estimates. All NONROAD model input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel who were not involved in the development of the modeling inputs/outputs and spreadsheets. In addition, the emissions estimates were reviewed for reasonableness by external agency staff.

4.15 References

- ENVIRON *et al.*, 2003. Maricopa County 2002 Comprehensive Emission Inventory for the Cap and Trade Oversight Committee, Final Rep. prepared for Arizona Dept. of Environmental Quality, October 9, 2003.
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